HYDRO STATICS

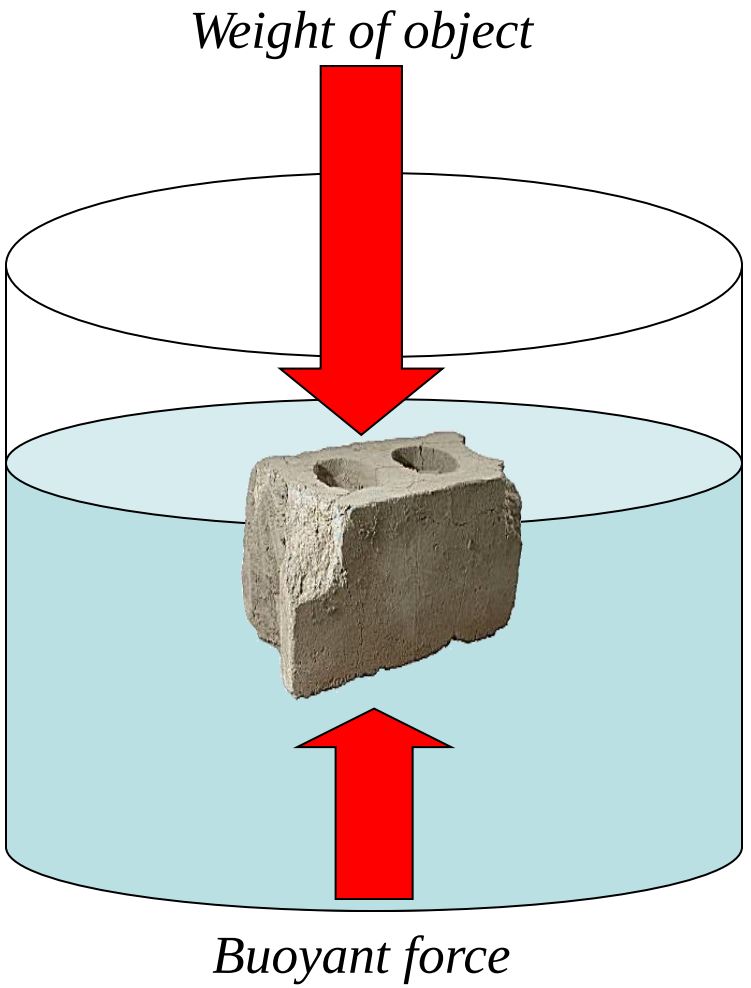
BUOYANCY

Fluid Action on Surfaces

Buoyancy

Buoyancy is the ability to float in a fluid (*i.e.* water and air).

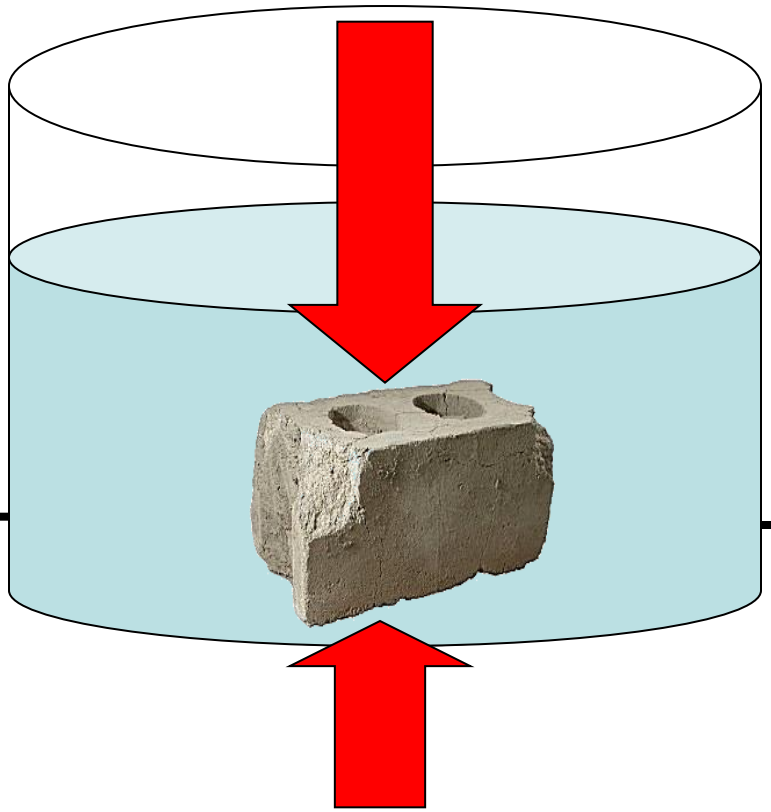
BUOYANT FORCE is the upward force that acts on a submerged object acting opposite of gravity.

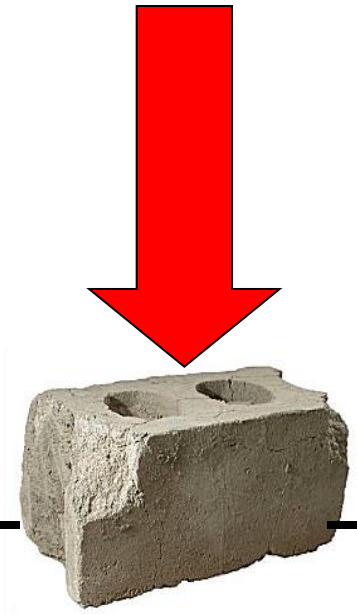


Fluid Action on Surfaces

Buoyancy

Which one is easier to pick up? Why?

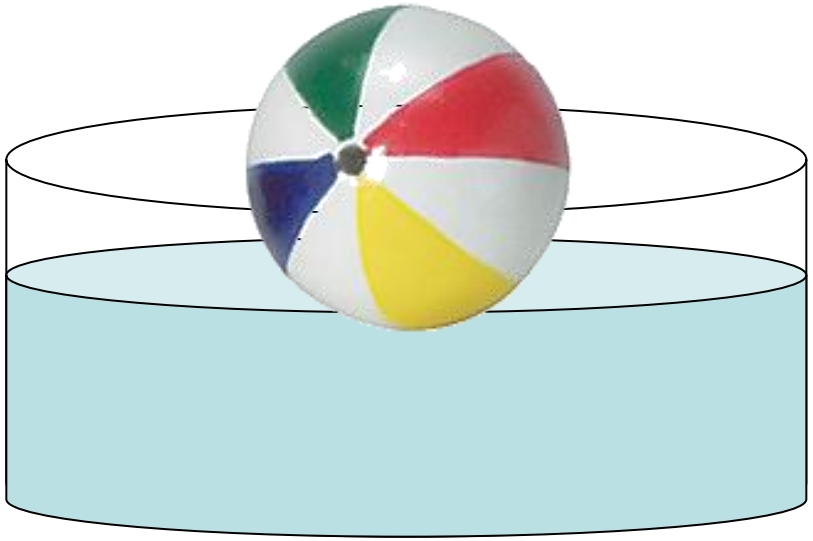




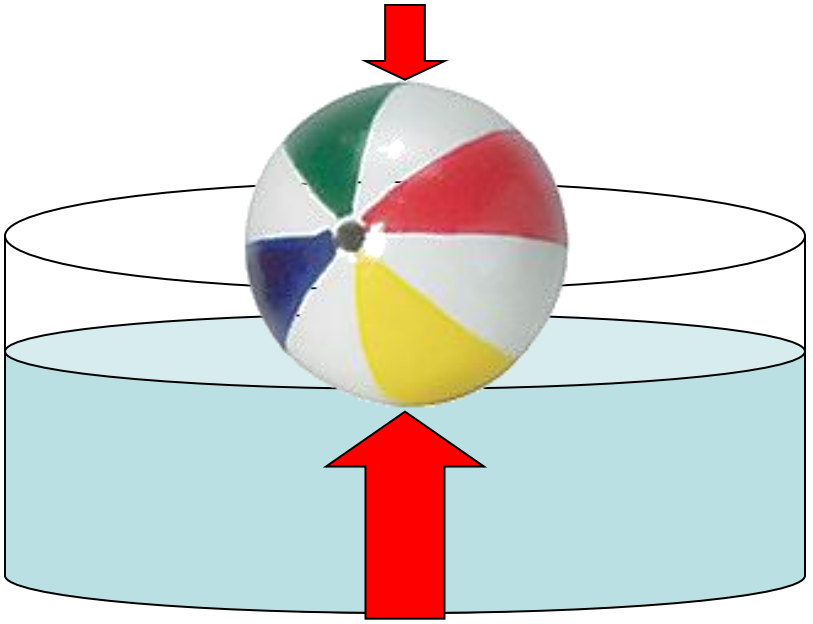
Fluid Action on Surfaces

Buoyancy

This beach ball floats. Why?



Because the buoyant force is greater than the weight of the ball.

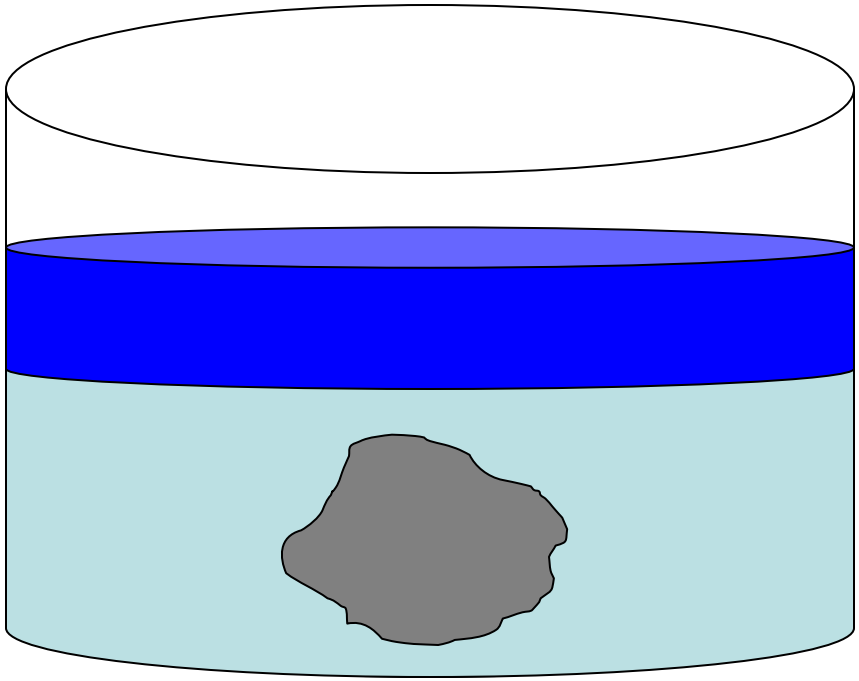


Fluid Action on Surfaces

Buoyancy

Archimedes' Principle

"*Any body immersed in a fluid is acted upon by an upward force (buoyant force) equal to the weight of the displaced fluid*."



Weight of displaced fluid

Fluid Action on Surfaces

Buoyancy

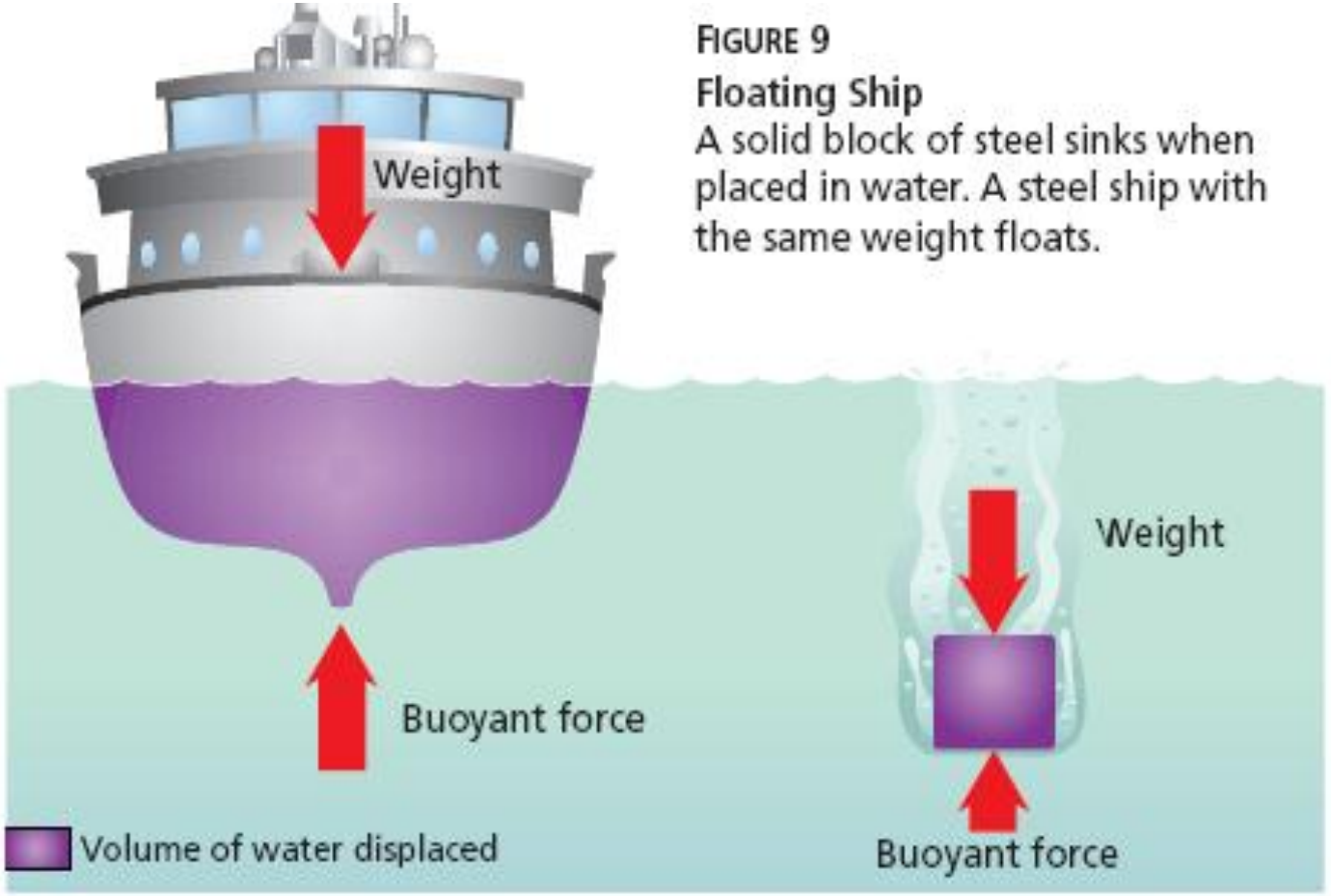
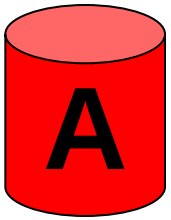


FIGURE 9
Floating Ship
A solid block of steel sinks when placed in water. A steel ship with the same weight floats.

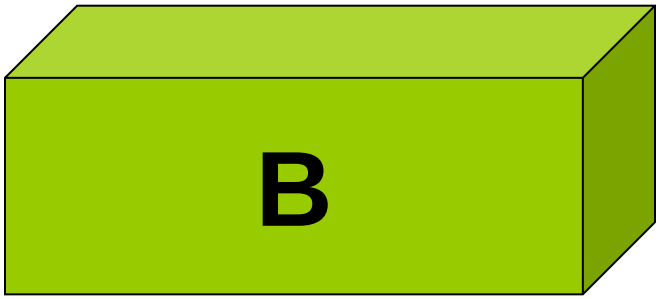
Fluid Action on Surfaces

Buoyancy

Mass = 90 kg



Mass = 90 kg



WHICH ONE IS MORE LIKELY TO FLOAT?

Fluid Action on Surfaces

Buoyancy

Density

Doesn't density have something to do with if something sinks or floats?

$$\rho = M / V \quad (\rho_{water} = 1 \text{ g/cc})$$

If the object has a higher density, it sinks.

If the object has a lower density, it floats.

if the object has the same density, it floats in the middle of the water.

Changing density

You can change an object's density by:

1. Increasing/decreasing its mass.
2. Increasing/decreasing its volume.

Figure 12
Submarine Density
Changes in density cause a submarine to dive or rise.
Comparing and Contrasting How does the weight of the submarine compare to the buoyant force in each case?

Fluid Action on Surfaces

Buoyancy

AN OBJECT SINKS

CAUSES:

- Weight is greater than the buoyant force.
- Object is denser than the fluid.
- Object increases its mass and becomes denser than the fluid.
- Object decreases its volume and becomes denser than the fluid.

Fluid Action on Surfaces

Buoyancy

AN OBJECT FLOATS

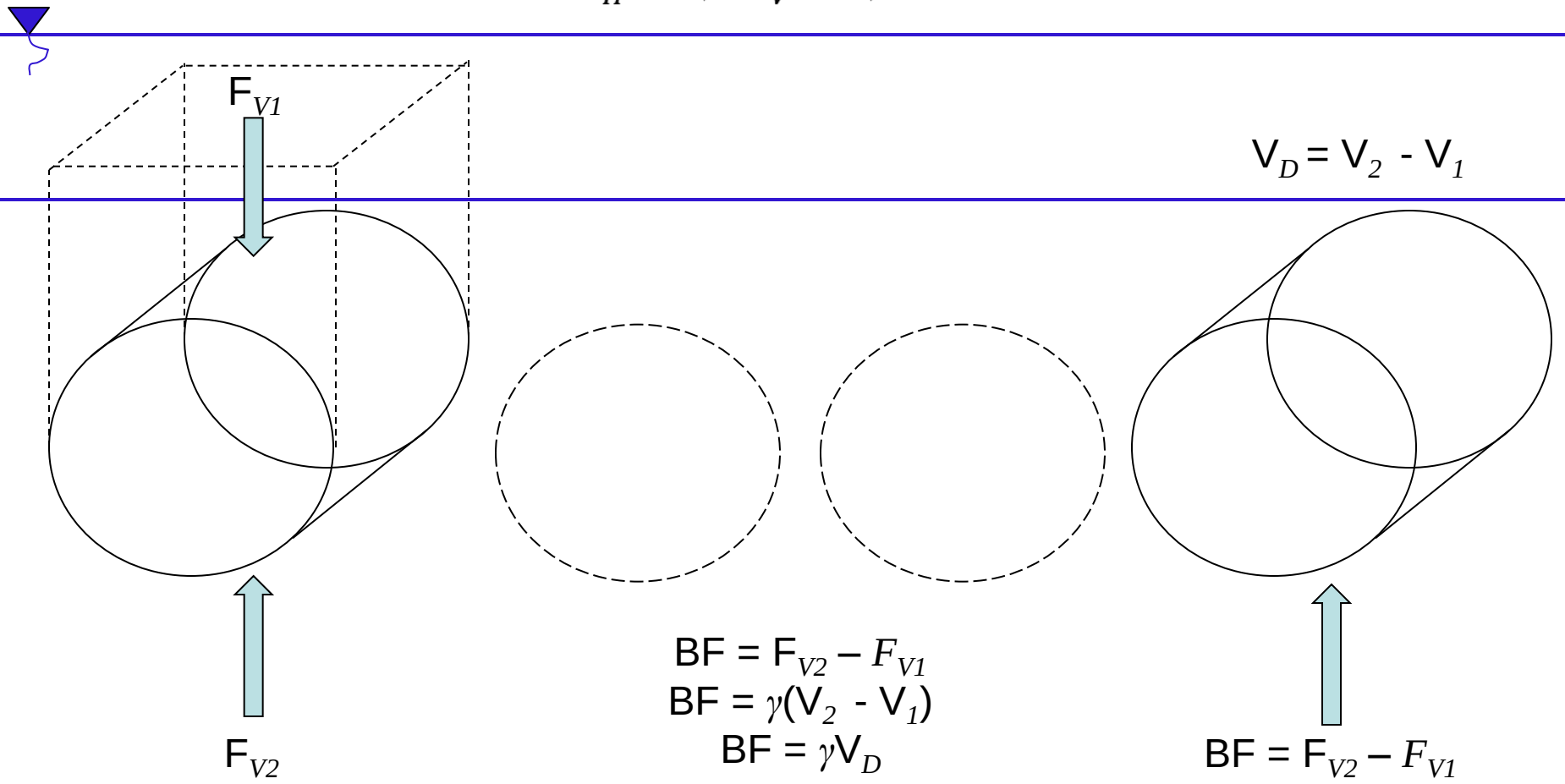
CAUSES:

- Weight is less than the buoyant force.
- Object is less dense than the fluid.
- Object decreases its mass and becomes less dense than the fluid.
- Object increases its volume and becomes denser than the fluid.

Fluid Action on Surfaces

To solve problems in buoyancy, identify the forces acting and apply conditions of static equilibrium:

$$\Sigma F_H = 0;\ \Sigma F_V = 0;\ \Sigma M = 0$$



Fluid Action on Surfaces

For homogeneous solid body of volume V "floating" in a homogeneous fluid at rest:

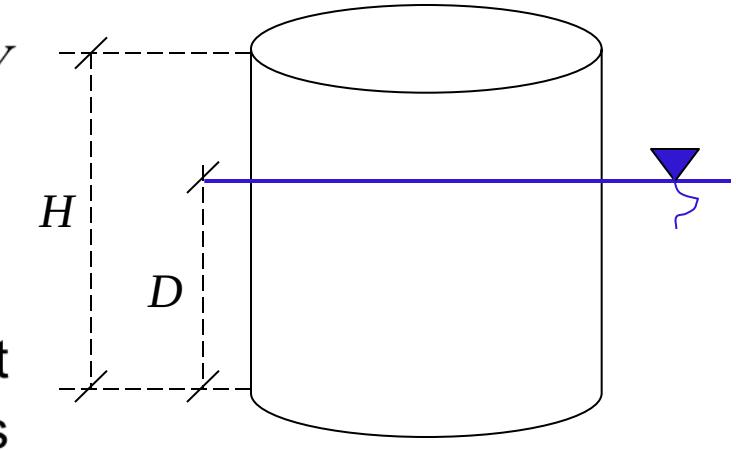
$$V_D = \frac{s_{body}}{s_{liquid}} V = \frac{\gamma_{body}}{\gamma_{liquid}} V$$

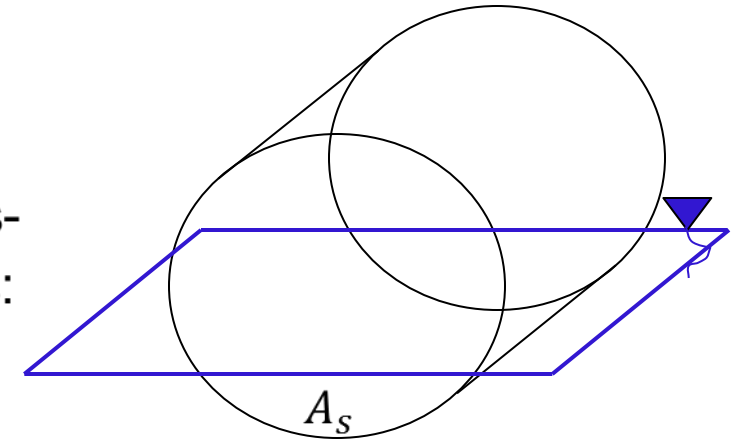
If the body of height H has a constant horizontal cross-sectional area such as vertical cylinders, blocks, etc.;

$$D = \frac{s_{body}}{s_{liquid}} H = \frac{\gamma_{body}}{\gamma_{liquid}} H$$

If the body is of uniform vertical cross-sectional area A, the area submerged A_s is:

$$A_s = \frac{s_{body}}{s_{liquid}} A = \frac{\gamma_{body}}{\gamma_{liquid}} A$$





Fluid Action on Surfaces

Problem Set 6

Problem 1

An iceberg having a specific gravity of 0.92 is floating on salt water of specific gravity of 1.03. If the volume of ice above the water surface is 1000 m^3, what is the total volume of the ice?

Fluid Action on Surfaces

Problem Set 6

Problem 2

A block of wood 0.60 m x 0.60 m x h meters in dimension was thrown into the water and floats with 0.18 m projecting above the water surface. The same block was thrown into a container of a liquid having a specific gravity of 0.90 and it floats with 0.14 m projecting above the surface. Determine the following:

2.1 the value of h,

2.2 the specific gravity of the block, and

2.3 the weight of the block.

Fluid Action on Surfaces

Problem Set 6

Problem 3

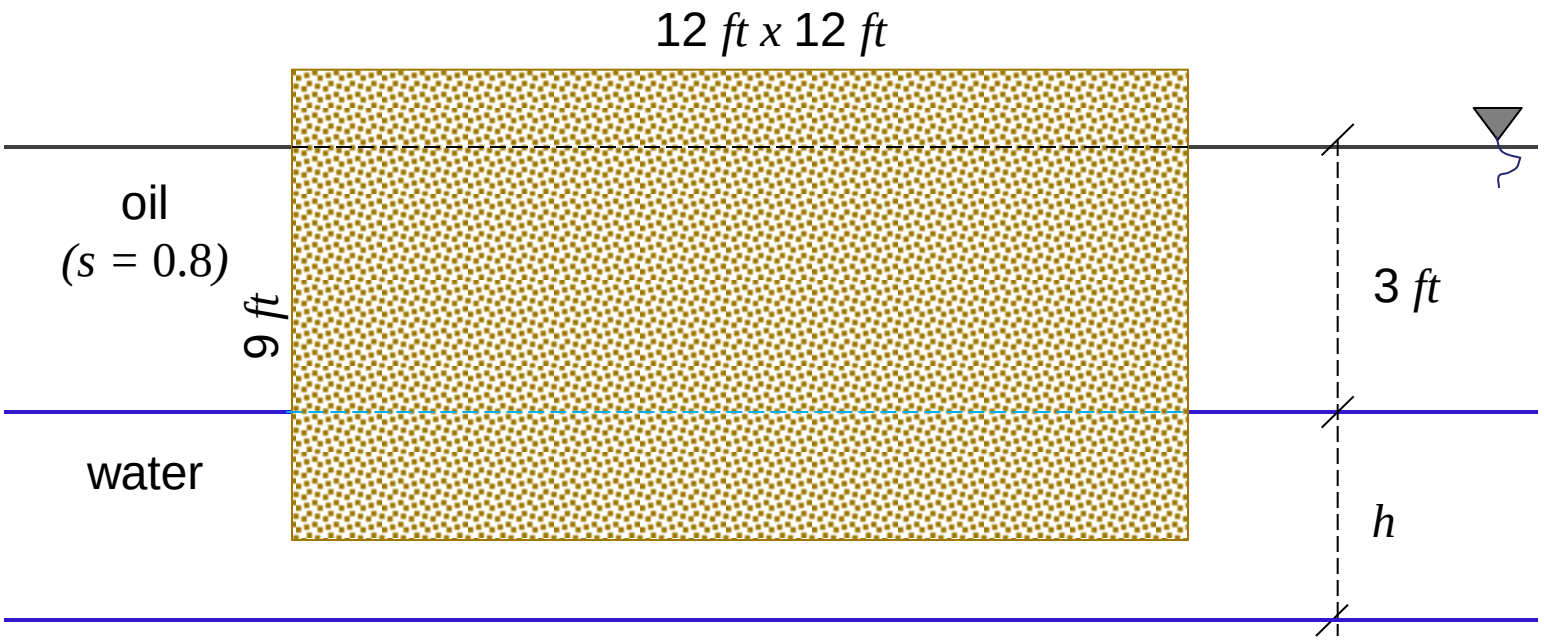
A stone weighs 460 N in air. When submerged in water, it weighs 300 N. Find the volume and specific weight of the stone.

Fluid Action on Surfaces

Problem Set 6

Problem 4

The block shown in the figure weighs 35,000 *lbs*. Find the value of *h*.

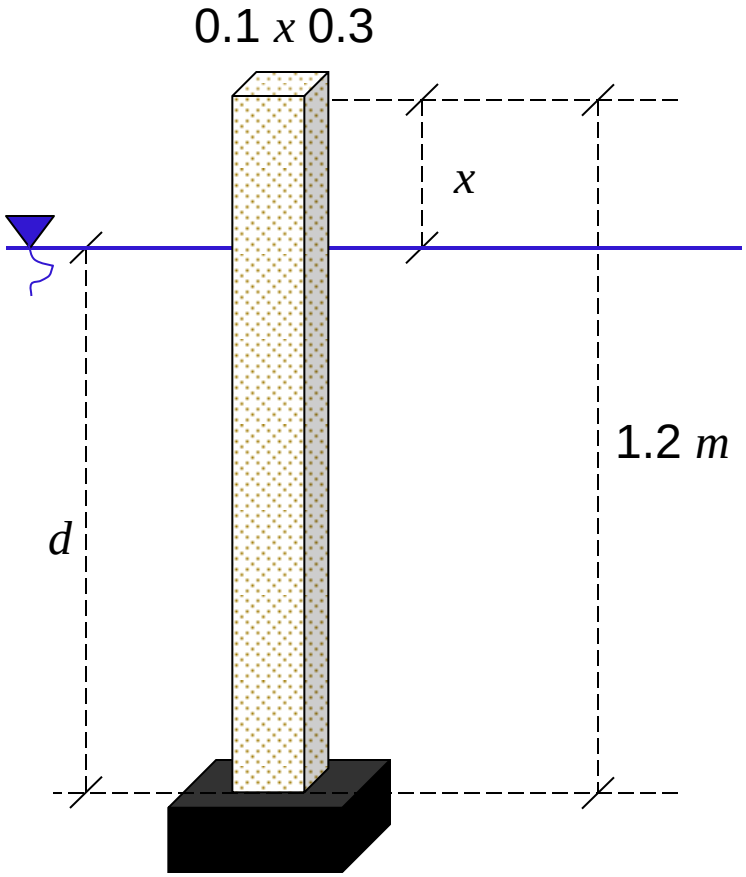


Fluid Action on Surfaces

Problem Set 6

Problem 5

If a 5-*kg* steel plate (s = 7.85) is attached to one end of a 0.1 *m* *x* 0.3 *m* *x* 1.20 *m* wooden pole (s = 0.50), what is the length of the pole above water?



Fluid Action on Surfaces

Problem Set 6

Problem 6

To what depth will a 2-m diameter log, 4 m long and specific gravity of 0.425 sink in fresh water?